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HYDRODYNAMIC COEFFICIENTS OF THE MK 13-2 TORPEDO

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ABSTRACT

Force measurement runs were made on a model MK 13-2 Torpedo to correct previously reported results for the discrepancies which were attributable to the interaction of pitching moment on the force measuring apparatus. The plain body, the body with fins, and the body with a shroud ring tail were tested at yaw angles of -10 degrees to +10 degrees. Drag-force coefficients, cross-force coefficients, and yawing moment coefficients were calculated and are presented in this report.

INTRODUCTION

The results from experimental force measurements made in the High Speed Water Tunnel in the past have shown considerable variation when the model was supported at different points along its length. The Experimental Towing Tank of the Stevens Institute of Technology has recently compiled the results of force tests on the MK 13-2.[1] The Stevens report contains results from the David Taylor Model Basin, the Wind Tunnel of the Naval Torpedo Station at Newport, and the Experimental Towing Tank. Discrepancies among the various sources are very obvious as well as the discrepancies in the results presented by this laboratory. The interaction of pitching moment on the force measuring apparatus has been shown to be the cause of the discrepancies in our data.[2] An internal pitching moment balance has been fabricated to allow determination of the pitching moment so that the other forces can be properly corrected. The laboratory's 2-inch diameter models of the MK 13 have been tested by this technique to correct the previously published data. The results of these tests are given in this report.

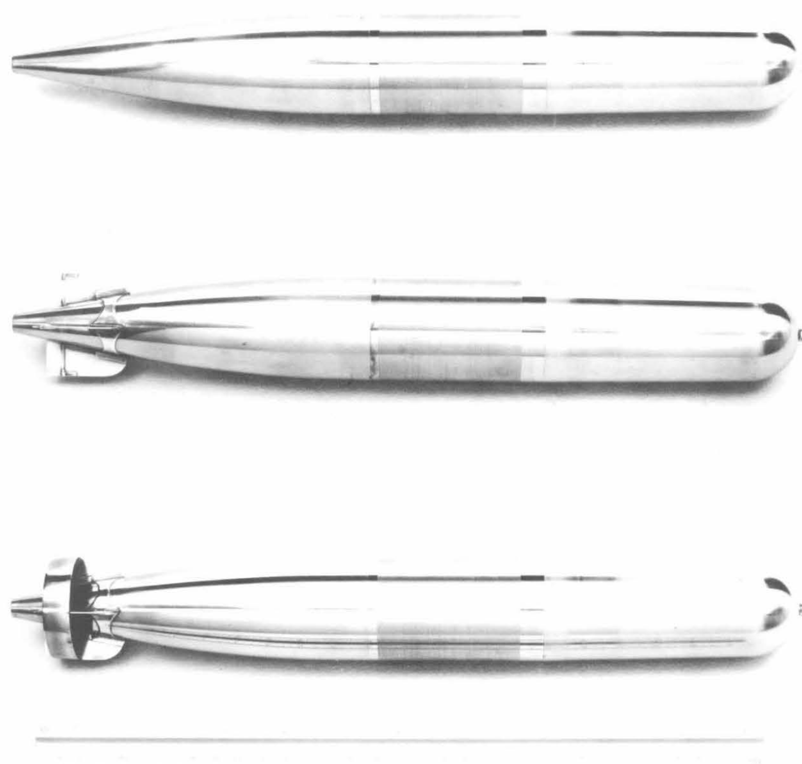

Fig. 1 - Two-inch diameter models of the MK 13-2 Torpedo

MODELS

Three models of the MK 13-2 were tested, Fig. 1. They were as follows:

1. A plain body without fins, (upper).
2. A body with fins only, (center).
3. A body with fins and a shroud ring, (lower).

The models were 14.37 inches long, and they were supported at 42.45% of the model length aft of the nose. The center of gravity used for the calculations (0.44 L aft of the nose) was based on data published by the Bureau of Ordnance.[3]

PROCEDURE

The models were tested at yaw angles from $+10^{\circ}$ to -10° at a velocity of 30 fps. Drag forces, cross forces, and yawing moments were obtained. Pitching moment readings were taken to obtain corrections which were applied to the other forces.

The model with the shroud ring tail was tested above, at 20, 30, and 40 fps to observe the effect of velocity upon the force coefficients.

Drag forces were measured at zero degrees yaw for velocities from 10 to 70 fps.

A duplicate run was made for each test incorporating a dummy image shield to provide the support interference corrections.

RESULTS

Figures 2, 3, and 4 show the effect of velocity on the force coefficients of the MK 13 with a shroud ring tail. The drag coefficient curves, Fig. 2, vary as expected at small angles of yaw. Beyond 8° yaw the curves seem to approach a common curve. The cross-force coefficients, Fig. 3, show a small increase over the velocities tested. The moment coefficient curves, Fig. 4, show no definite velocity trends. Based on a study of these graphs, the remainder of the tests were conducted at a velocity of 30 fps.

Figures 5 through 7 show the curves of force coefficients for each individual model. Previously reported data is also included for comparison.

Drag coefficients at zero angle of yaw are presented in Fig. 8 as a function of Reynolds number. The difference that occurs between the new and the old data can be entirely accounted for by the pitching moment.

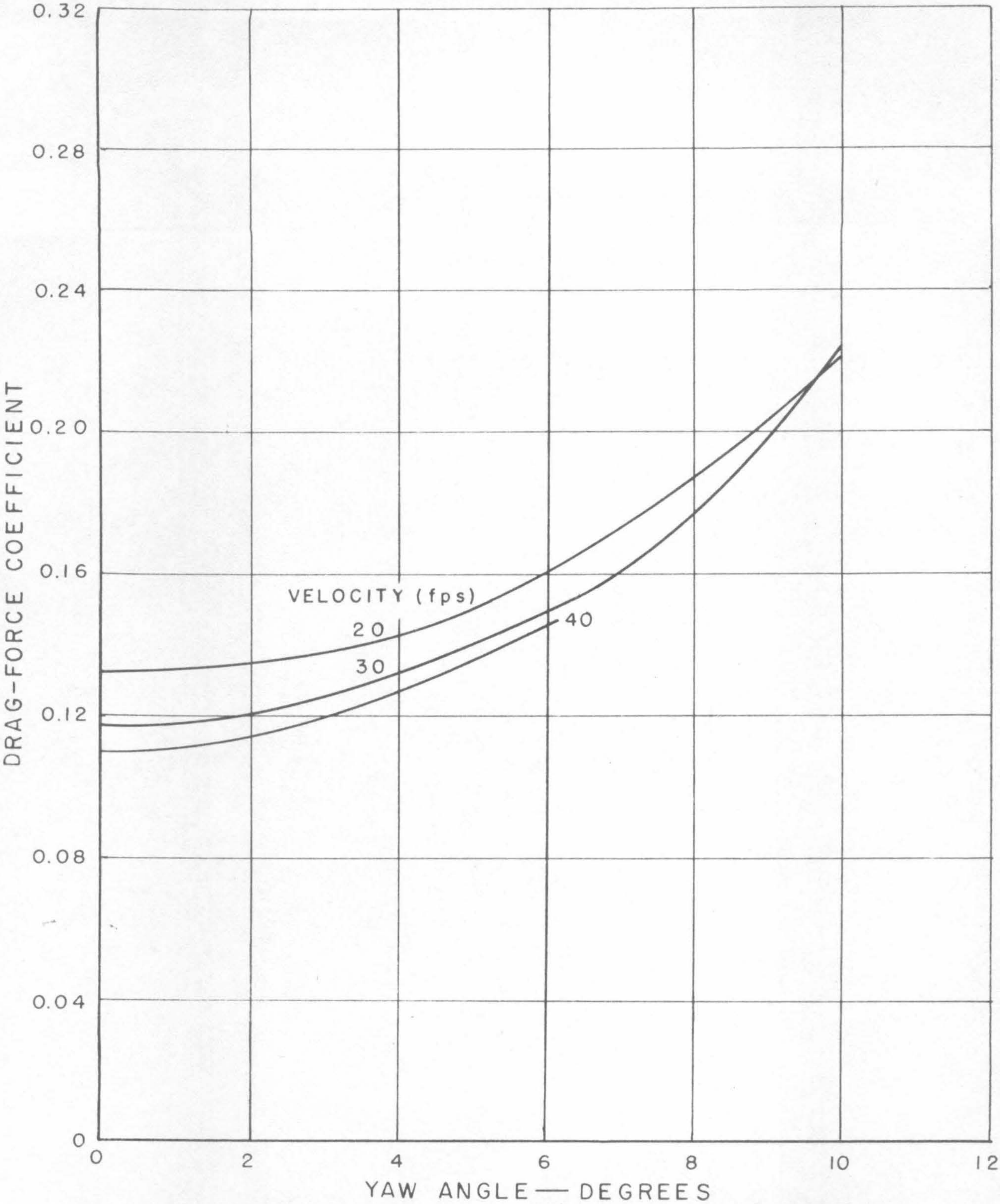

Fig. 2 - The effect of yaw on drag coefficient at several velocities for the Mk 13-2 torpedo with shroud-ring tail

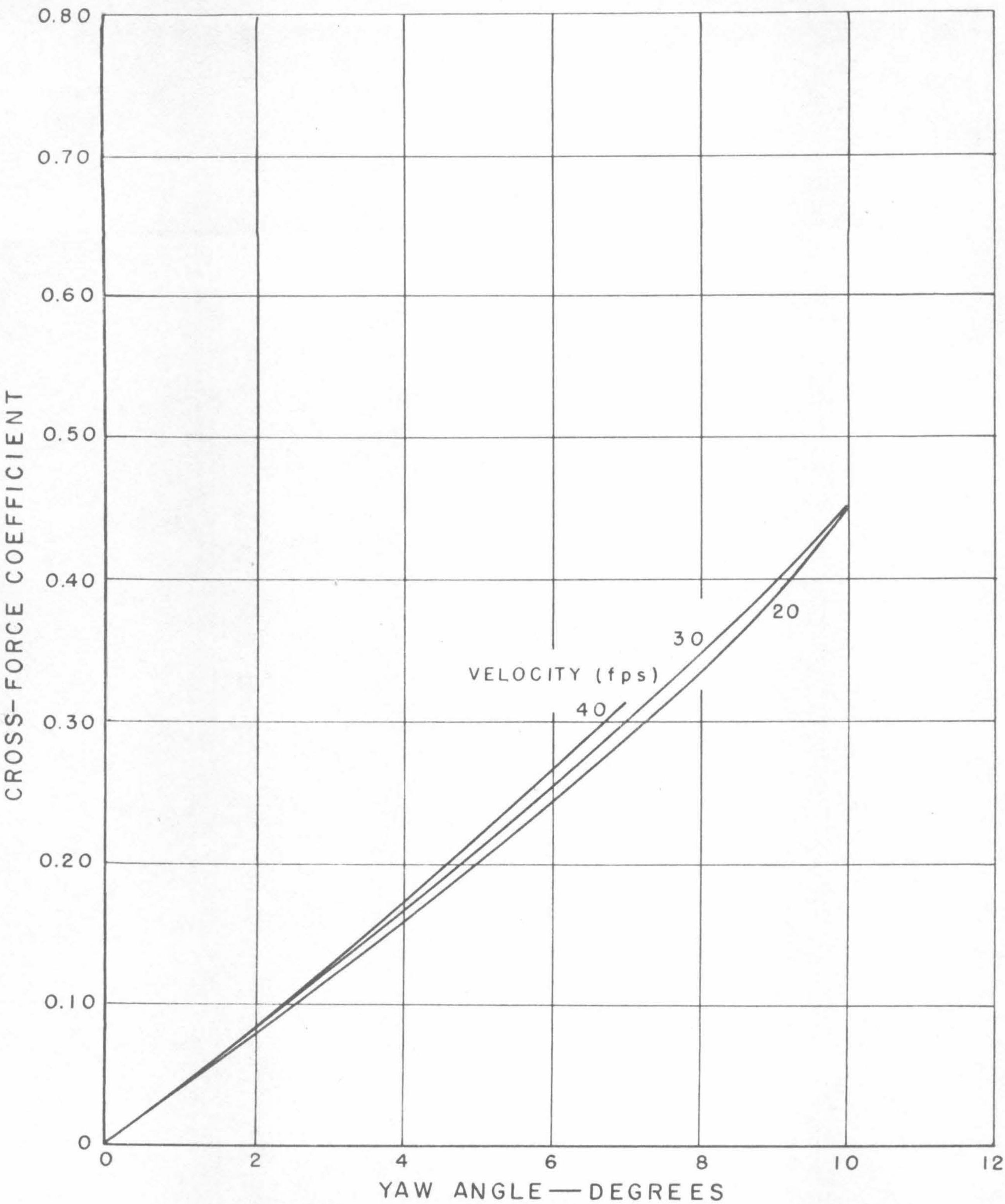

Fig. 3 - The effect of yaw on the cross-force coefficient at several velocities for the Mk 13 torpedo with shroud-ring tail

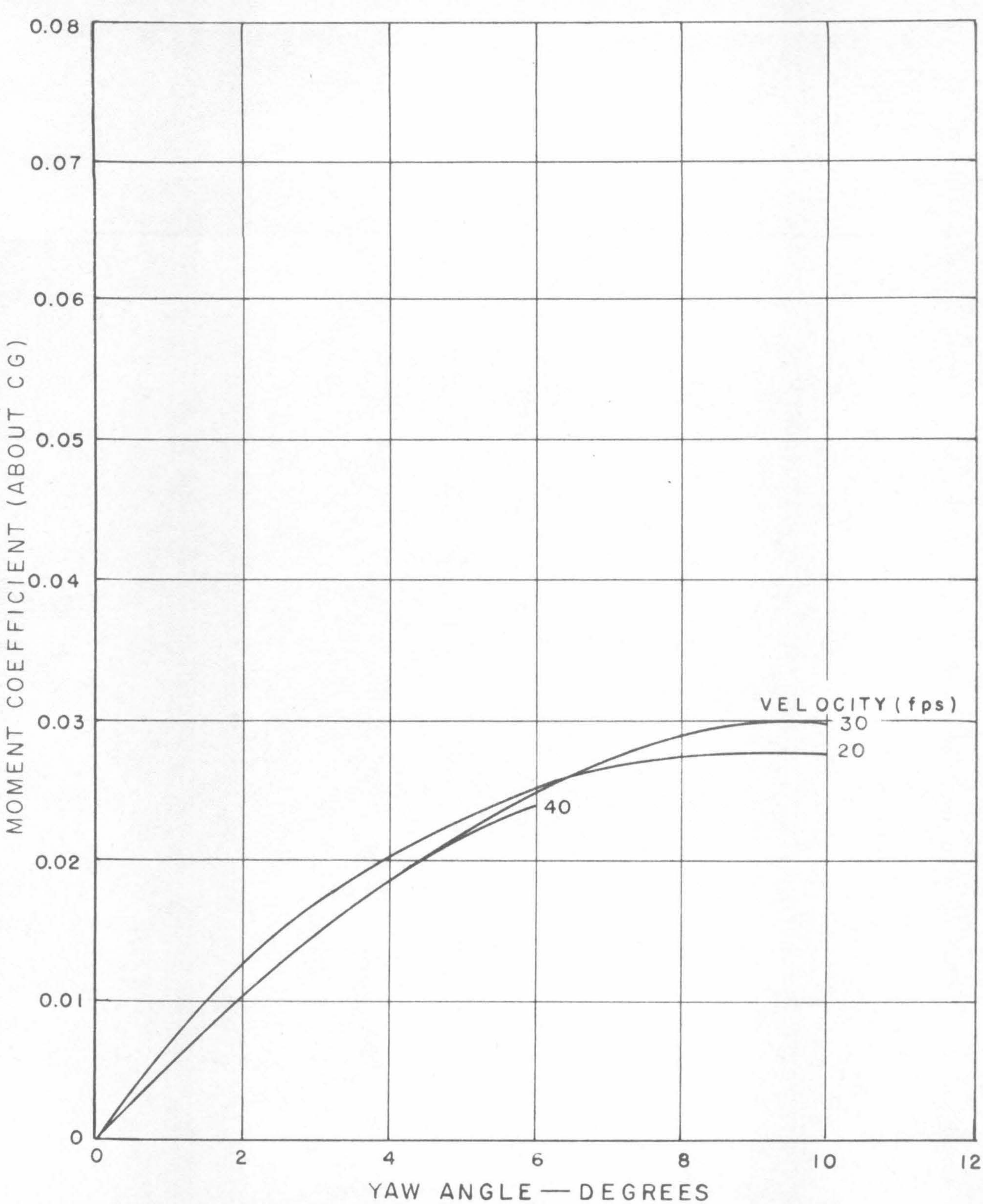

Fig. 4 - The effect of yaw on the moment coefficient at several velocities for the Mk 13-2 torpedo with shroud-ring tail

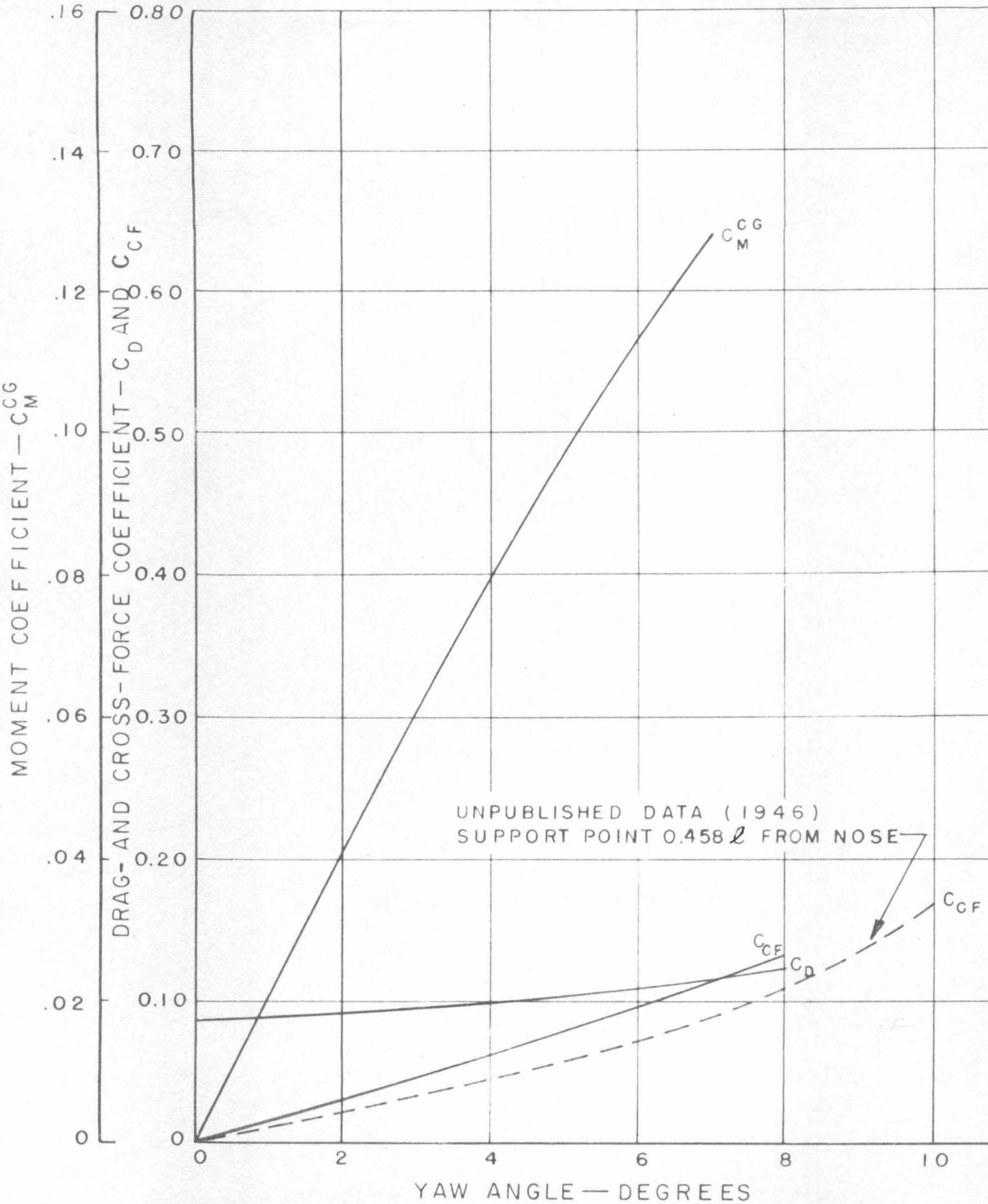

Fig. 5 - Hydrodynamic coefficients vs yaw for the Mk 13-2 bare hull
Reynolds number (based on length) 3.6×10^6

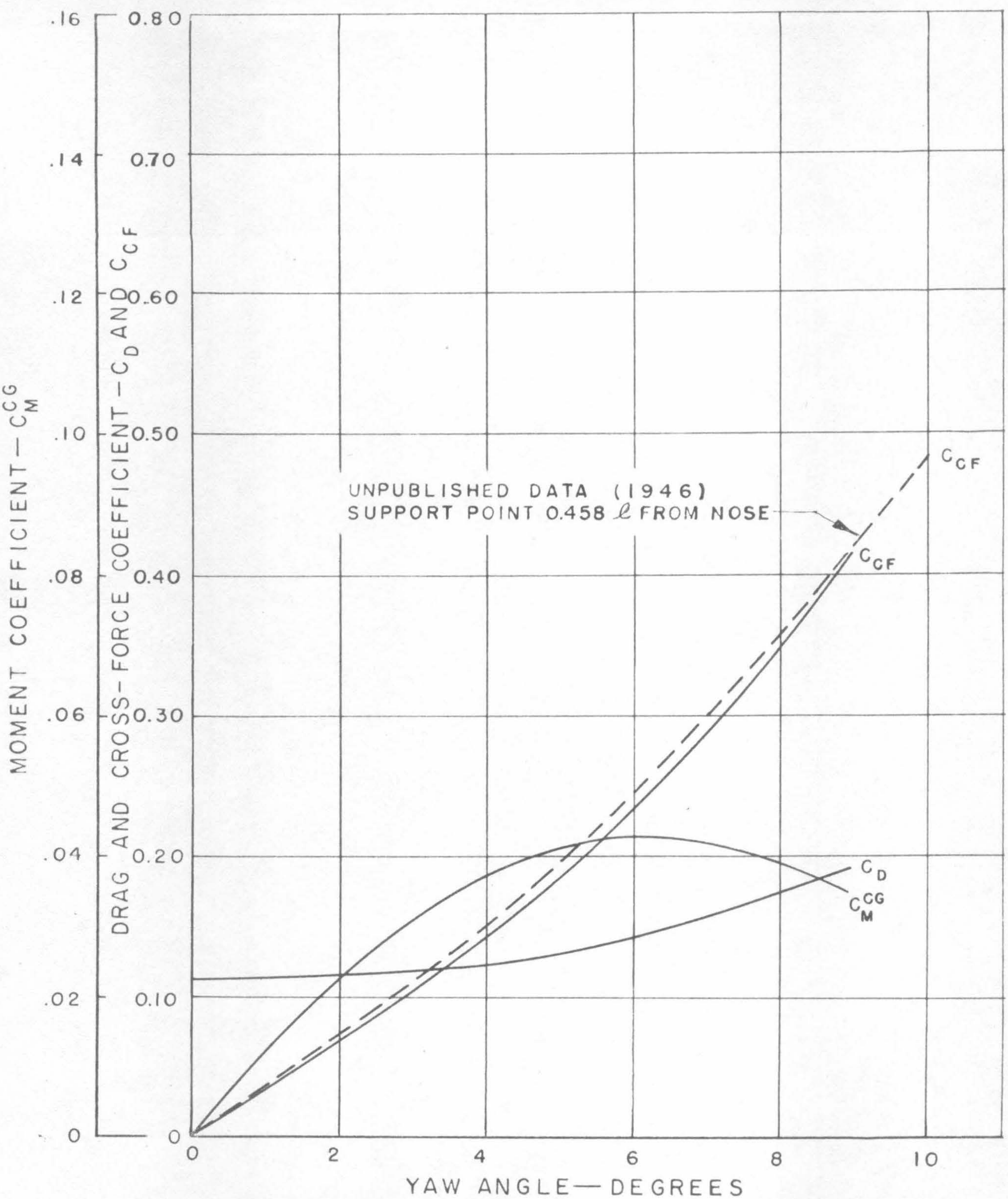

Fig. 6 - Hydrodynamic coefficients vs yaw for the Mk 13-2 with plain fins
Reynolds number (based on length) 3.6×10^6

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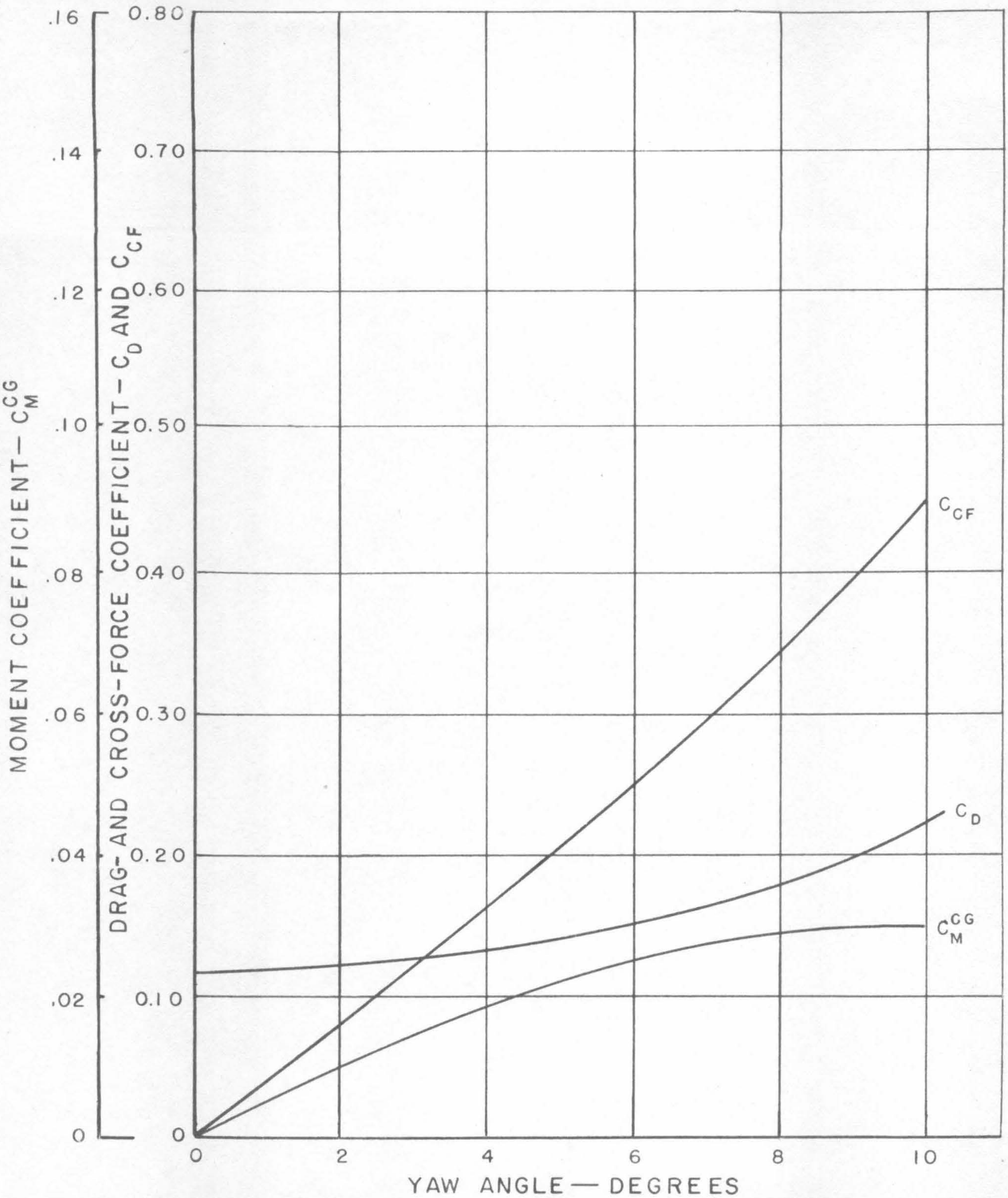

Fig. 7 - Hydrodynamic coefficients vs yaw for the Mk 13-2 torpedo with a shroud-ring tail
Reynolds number (based on length) 3.6×10^6

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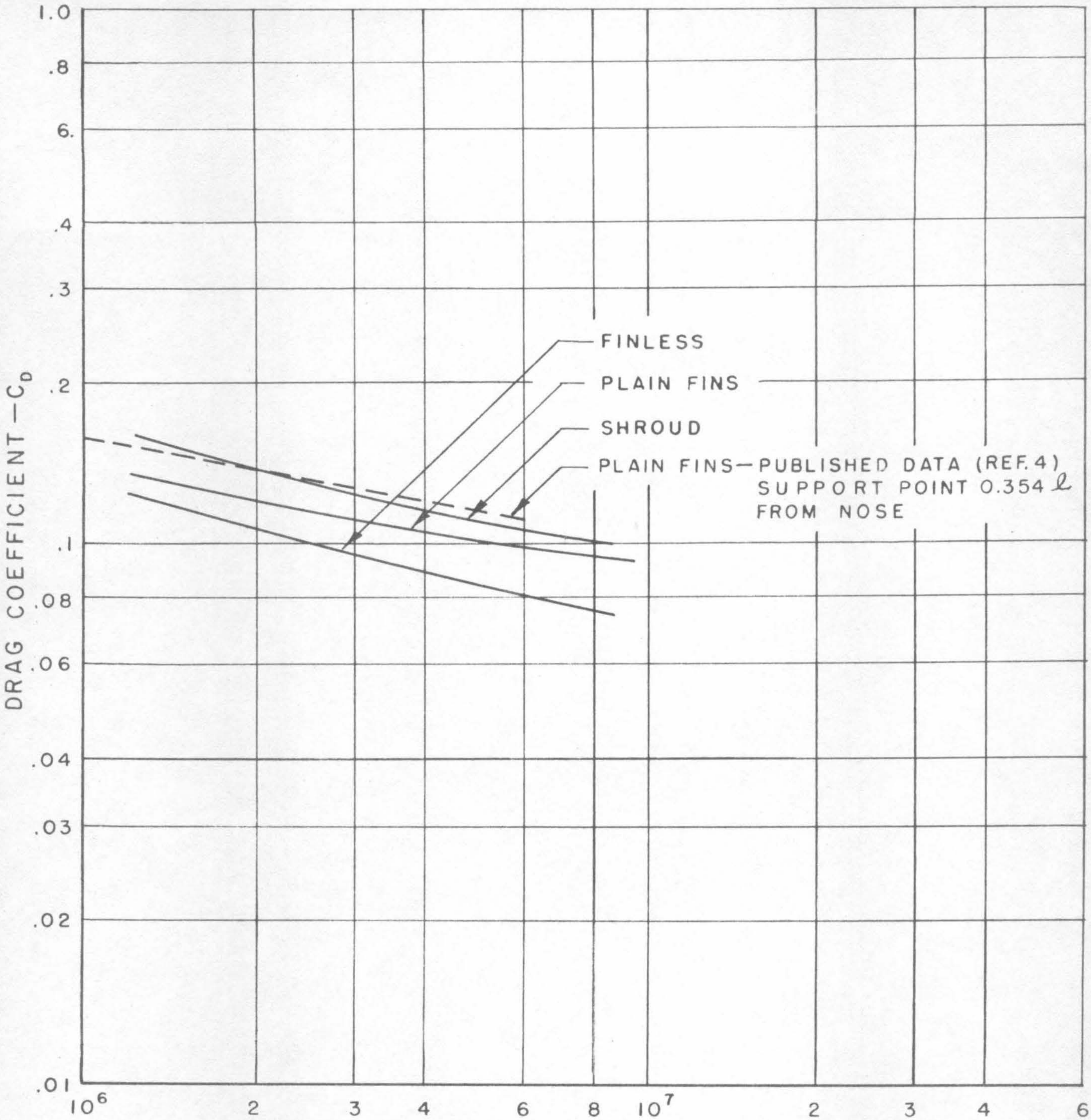

Fig. 8 - The effect of Reynolds number on the drag coefficient for all three configurations of the Mk 13-2 torpedo, yaw angle 0^o

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